What is claimed is:

1. An apparatus for suppressing noise in a communications system, the apparatus comprising:

a filter bank connected to an input signal and including multiple subband outputs;

a voice activity detector connected to said input signal and including a voice detection signal output;

a power estimator connected to said voice detection signal and multiple subband outputs and including multiple short-term power estimate outputs representative of noisy signal power, and including multiple long-term power estimate outputs representative of noise power;

a noise to signal ratio (NSR) adapter connected to said multiple long-term power estimate outputs, said multiple short-term power estimate outputs, and said voice detection signal output, said adapter including multiple adapted NSR outputs;

a gain computation circuit connected to said multiple adapted NSR outputs, and including multiple gain factor outputs;

a gain multiplier connected to said multiple gain factor outputs and said multiple subband outputs, said gain multiplier including multiple scaled signal outputs; and

a combiner connected to at least said multiple scaled signal outputs, said combiner including a combined signal output.

2. The apparatus of claim 1 further comprising an overall NSR estimator connected to said input signal and said voice detection signal output and including an overall NSR output, and wherein said NSR adapter is connected to said overall NSR output, and said multiple adapted NSR outputs are responsive to said overall NSR output.

3. The apparatus of claim 2 wherein said overall NSR estimator includes circuitry that determines a noisy signal power estimate responsive to said voice detection signal output and a noise power estimate responsive to said voice detection signal output.

4. The apparatus of claim 3 wherein said circuitry determines said noisy signal power estimate responsive to undersampling said input signal.

5. The apparatus of claim 3 wherein said circuitry determines said noise power estimate responsive to undersampling said input signal.

6. The apparatus of claim 3 wherein said noisy signal power estimate is determined by the formula:

$$P_{SIG}(n) = \begin{cases} \beta_{SIG} P_{SIG}(n-1) + \alpha_{SIG} \, |x(n)| \, , & n = 0, 2T, 3T, \ldots \\ P_{SIG}(n-1) \, , & n = 1, 2, \ldots T-1, T+1, \ldots 2T-1, \ldots \end{cases}$$

where T represents an undersampling period, α_{SIG} and β_{SIG} are predetermined constants, and x(n) represents said input signal at sample n.

7. The apparatus of claim 3 wherein said noise power estimate is determined by the formula:

$$P_{BN}(n) = \begin{cases} \max[\beta_{BN} P_{BN}(n-1) + \alpha_{BN} \mid x(n) \mid, P_{BN,max}], n = 0, 2T, 3T, \ldots \\ P_{BN}(n-1) \qquad , n = 1, 2, \ldots T-1, T+1, \ldots 2T-1, \ldots \end{cases}$$

where T represents an undersampling period, α_{BN} and β_{BN} are predetermined constants, x(n) represents said input signal at sample n, and $P_{BN,max}$ represents a maximum background noise power.

8. The apparatus of claim 3 wherein said overall NSR output represents the difference between said noisy signal power estimate and said noise power estimate multiplied by a predetermined constant.

9. The apparatus of claim 3 wherein said NSR output is determined by the formula:

$$NSR_{overall}(n) = \begin{cases} \upsilon_1 P_{BN}(n) & , \quad P_{SIG}(n) < \kappa_1 P_{BN}(n) \\ \upsilon_2 P_{BN}(n) & , \quad P_{SIG}(n) \geq \kappa_2 P_{BN}(n) \\ \upsilon_3 [P_{BN}(n) - P_{SIG}(n)] & , \kappa_2 P_{BN}(n) > P_{SIG}(n) \geq \kappa_3 P_{BN}(n) \end{cases}$$

where ν_{1-3} and κ_{1-3} are predetermined constants, P_{BN}(n) represents said noise power estimate and P_{SIG}(n) represents said noisy signal power estimate.

10. The apparatus of claim 1 wherein said power estimator includes said multiple short-term power estimate outputs responsive to undersampled multiple subband

outputs.

11. The apparatus of claim 1 wherein said power estimator includes said multiple long-term power estimate outputs responsive to undersampled multiple subband outputs.

12. The apparatus of claim 1 wherein said NSR adapter includes said multiple adapted NSR outputs responsive to scaled long-term power estimate outputs and scaled short-term power estimate outputs.

13. The apparatus of claim 1 wherein said power estimator includes said multiple short-term power estimate outputs responsive to scaled multiple subband outputs, thereby attempting to avoid overflow or underflow.

14. The apparatus of claim 1 wherein said power estimator includes multiple long-term power estimate outputs responsive to scaled multiple subband outputs. thereby attempting to avoid overflow or underflow.

15. The apparatus of claim 1 wherein said voice detection signal output is responsive to power measured between approximately 300 Hz and approximately 850 Hz of said input signal.

16. The apparatus of claim 1 wherein said multiple long-term power estimate outputs are constant during non-silence.

17. The apparatus of claim 1 wherein said filter bank comprises a resonator bank of k resonators, and said long-term power estimate output corresponding to the kth resonator is responsive to the formula:

$$P_{LT}^{k}(n) = \begin{cases} \beta_{LT} P_{LT}^{k}(n-1) + \alpha_{LT} \mid x_k(n) \mid & , \quad n = 0, 2T, 3T, \ldots \\ P_{LT}^{k}(n-1) & , \quad n = 1, 2, \ldots T-1, T+1, \ldots 2T-1, \ldots \end{cases}$$

where T represents an undersampling period, α_{LT} and β_{LT} are predetermined constants, and x_k (n) represents the kth subband of a multiple subband signal.

18. The apparatus of claim 1 wherein said filter bank comprises a resonator bank of k resonators, and said short-term power estimate corresponding to the kth resonator is responsive to the formula:

$$P_{ST}^{k}(n) = \begin{cases} \beta_{ST} P_{ST}^{k}(n-1) + \alpha_{ST} NSR_k(n) \mid x_k(n) \mid & , \quad n = 0, 2T, 3T, \ldots \\ P_{ST}^{k}(n-1) & , \quad n = 1, 2, \ldots T-1, T+1, \ldots 2T-1, \ldots \end{cases}$$

where T represents an undersampling period, α_{LT} and β_{LT} are predetermined constants, $x_k(n)$ represents the kth subband of a multiple subband signal, and NSR_k (n) represents the NSR of the kth subband at sample n.

19. A method for suppressing noise in a communications system, the method comprising:

accepting an input signal comprising a plurality of subbands;

detecting whether speech is present in said input signal including measuring power in said input signal to form a speech detection signal;

estimating power in said plurality of subbands to form a plurality of long-term power estimates and a plurality of short-term power estimates;

forming at least one adapted NSR in at least one of said plurality of subbands responsive to said voice detection signal, said plurality of long-term power estimates and said plurality of short-term power estimates;

forming a gain factor signal in at least one of said plurality of subbands responsive to said at least one adapted NSR;

scaling at least one of said plurality of subbands responsive to said at least one gain factor signal to form at least one scaled subband; and

forming an output signal responsive to said at least one scaled subband.

20. The method of claim 19 further comprising forming an overall NSR and wherein said adapted NSR forming step comprises forming said adapted NSR signal responsive to said overall NSR.

21. The method of claim 19 further comprising forming a long-term first formant power estimate and a short-term first formant power estimate and wherein said detecting step comprises detecting whether speech is present in said input signal responsive to said long-term and short-term estimates.

22. The method of claim 21 wherein said step of forming at least one of the long-term power estimates comprises:

providing a full-rate filtered input signal;

undersampling at least a portion of the full-rate filtered input signal to form an undersampled signal;

scaling the undersampled signal to avoid overflow or underflow; and

responsively determining a scaled power measure of at least a portion of the full-rate filtered input signal.

23. The method of claim 21 wherein said step of forming at least one of the short-term power estimates comprises:

providing a full-rate filtered input signal;

undersampling at least a portion of the full-rate filtered input signal to form an undersampled signal;

scaling the undersampled signal to avoid overflow or underflow; and

responsively determining a scaled power measure of at least a portion of the full-rate filtered input signal.

24. The method of claim 19 wherein said step of forming an adapted NSR comprises forming adapted NSRs for substantially all of a plurality of predetermined subbands

within a predetermined frequency range.

25. The method of claim 19 wherein said step of forming a gain factor signal comprises forming gain factor signals for substantially all of a plurality of predetermined subbands within a predetermined frequency range.

26. The method of claim 19 wherein said estimating step comprises:

providing a full-rate filtered input signal;

undersampling at least a portion of the full-rate filtered input signal to form an undersampled signal;

scaling the undersampled signal to avoid overflow or underflow; and

responsively determining a scaled power measure of at least a portion of the full-rate filtered input signal,

to form at least one of the long-term power estimates.

27. The method of claim 19 wherein said estimating step comprises:

providing a full-rate filtered input signal;

undersampling at least a portion of the full-rate filtered input signal to form an undersampled signal;

scaling the undersampled signal to avoid overflow or underflow; and

responsively determining a scaled power measure of at least a portion of the full-rate filtered input signal,

to form at least one of the short-term power estimates.

28. A method for measuring power comprising:

providing a full-rate filtered input signal;

undersampling at least a portion of the full-rate filtered input signal to form an undersampled signal;

scaling the undersampled signal to avoid overflow or underflow; and

responsively determining a scaled power measure of at least a portion of the full-rate filtered input signal.

29. The method of claim 28 wherein the step of determining a scaled power measure comprises determining a scaled power measure according to at least one of the formulas:

$$P_{SIG}(n) = \begin{cases} \beta_{SIG} P_{SIG}(n-1) + \alpha_{SIG} \, |x(n)| & , \; n = 0,2T,3T,\ldots \\ P_{SIG}(n-1) & , \; n = 1,2,\ldots T-1, T+1,\ldots 2T-1,\ldots \end{cases}$$

and

$$P_{BN}(n) = \begin{cases} \max[\beta_{BN} P_{BN}(n-1) + \alpha_{BN} \, |x(n)|, P_{BN,max}], & n = 0,2T,3T,\ldots \\ P_{BN}(n-1) & , \; n = 1,2,\ldots T-1, T+1,\ldots 2T-1,\ldots \end{cases}$$

where T represents an undersampling period, $\alpha_{SIG}, \beta_{SIG}, \alpha_{BN}$ and β_{BN} are predetermined constants, and x(n) represents said input signal at sample n.

30. A NSR adaptation apparatus comprising:

noise power measuring circuitry connected to an input signal and including a noise power measurement output;

signal power measuring circuitry connected to the input signal and including a noisy signal power measurement output;

a voice activity detector connected to the input signal and including a voice detection signal output; and

a NSR adapter connected to the noise power measurement output, the noisy signal power measurement output, and the voice detection signal output, said NSR adapter including an adapted NSR output responsive to one or more of said voice detection signal output, the difference between a noise power measurement and a noisy signal power measurement, the sign of the difference between a noise power measurement and a noisy signal power measurement, an instantaneous noise to signal power ratio. and the difference between the instantaneous noise to signal power ratio and a previous noise to signal power ratio.

31. The apparatus of claim 30 wherein said NSR adapter includes said adapted NSR output responsive to said voice detection signal output and the difference between a noise power measurement and a noisy signal power measurement.

32. The apparatus of claim 30 wherein said NSR adapter includes said adapted NSR output responsive to said voice detection signal output.

33. The apparatus of claim 30 wherein said NSR adapter modifies an NSR by an NSR change amount, wherein the NSR change amount is responsive to the voice detection signal output.

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